

The total volumetric clearance is very low, varying from 1² to 2 per cent according to the size of engine. Assuming a clearance volume of 2 per cent, the ratio of volumetric compression would then be 46, so that the pressure of the entrapped steam may be made almost equal to that of the inlet steam, the temperature of the steam and of the metal surfaces being raised at the same time. This feature also tends to reduce initial condensation. There must, of course, be some loss, as the compressed steam will lose heat by conduction in this process, and cannot therefore give out on the return stroke the same amount of work as was spent upon it, but the whole effect seems to be in favour of economy.

So large a ratio of compression cannot be obtained in ordinary engines because of the large clearance volumes, and it is very necessary that the inlet valves be kept perfectly tight. Even a small leakage of high-pressure steam into the cylinder from the steam chest during the compression stroke would result in a high final pressure, with a diminution of the work area of the indicator card. An impaired vacuum would have a similar effect, and the blowing of the cylinder relief valves would call attention to the trouble.

For full load the cut-off is only about 8 to 10 per cent of the piston stroke, and for 25 per cent overload a cut-off of only about 14 per cent would be required, so that this type of engine readily responds to varying power demands.

When working non-condensing, when starting up, and again when stopping, it is necessary to relieve the pressure in the cylinder during the compression stroke, to prevent the see-sawing action which might take place, and cause the belts on lines of shafting driven by the engine to be thrown off the pulleys.

There are various devices for relieving the pressure. A special valve is provided which allows the compressed steam to enter a space in the cylinder cover, thus temporarily increasing the clearance volume. In other cases the steam in the cylinder is by-passed to the exhaust by an automatic arrangement worked by the pressure in the exhaust belt. The arrange-

ment adopted by Messrs. Robey & Co. is shown in fig. 7. The valve in the cover is operated by a cam on a rocking shaft driven by an eccentric mounted on the valve-gear lay shaft, through a clutch which is put into gear by the spring-controlled piston working in a cylinder in communication with the exhaust. When there is a poor vacuum or when the engine is working non-condensing, the clutch is put into gear by the spring and the cams operate the relieving valves, but when condensing, the clutch is disengaged by the vacuum, the cam-shaft is stationary, and the valves remain closed. Messrs. Cole, Marchent, & Morley use their steam ejector air pump of the Delas type for starting up, by creating a vacuum in the condenser before admitting steam to the engine.

Where considerable quantities of heating steam at moderate pressures are required for process work, a compound engine is often employed, consisting of an ordinary high-pressure cylinder and a low-pressure Uniflow